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(12) UK Patent Application (19) GB (11) 2 259 823 (13) A

(43) Date of A publication 24.03.1993

(21) Application No 9119860.6

(22) Date of filing 17.09.1991

(51) INT CL[5]
G05D 1/03, G01S 3/783 5/16

(52) UK CL (Edition L)
H4D D714 D733 D77X D78X D782
U1S S1820 S1875

(56) Documents cited
GB 2224613 A EP 0296405 A EP 0273976 A
EP 0236614 A WO 87/02484 A US 4967064 A

(58) Field of search
UK CL (Edition K) G3N NGA3 NGBX NG1A4 NG5, H4D DLAB DLFB DLPA DLPC DLPG
INT CL[5] G05D

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(54) Navigation system

(57) A navigation system carried on board a remotely controlled robotic vehicle comprises a TV camera 3 whose output is processed by computer 5 to provide the position of the vehicle with respect to coded reflectors 2. The reflectors are illuminated by lights 1 whose output intensities are controlled by computer 5. The system provides the vehicle's control system with information relating to its physical location with respect to a fixed origin and also measures the angle of orientation of the vehicle.

Reflector, operational boundary and obstacle position data relating to a number of possible operating environments may be stored in a memory.

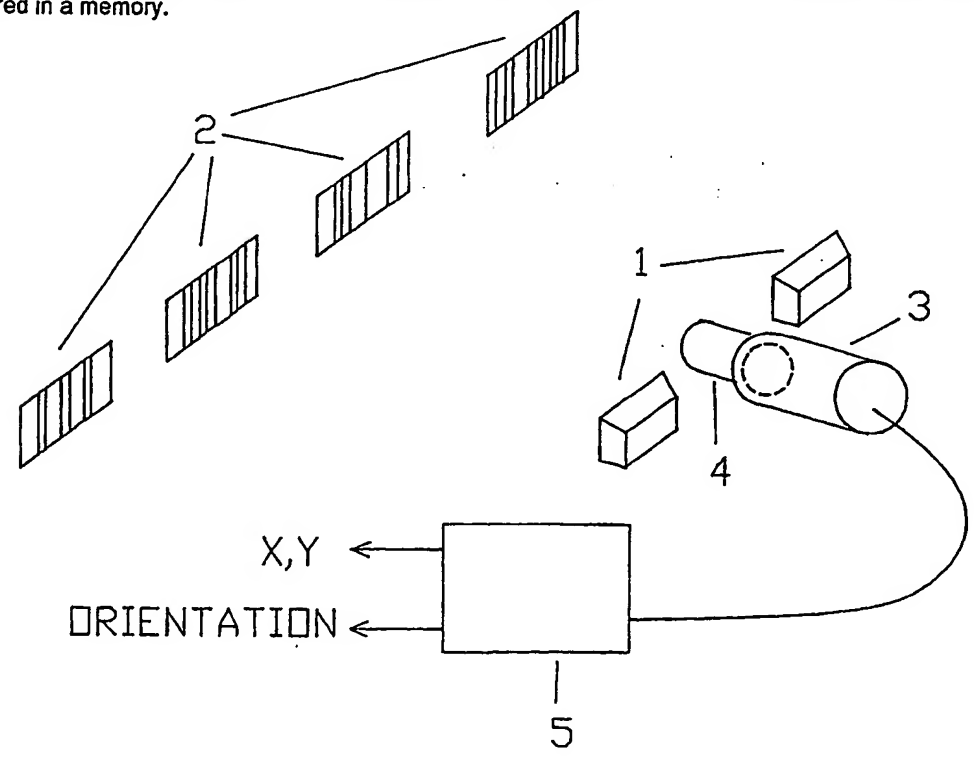

FIG -1-

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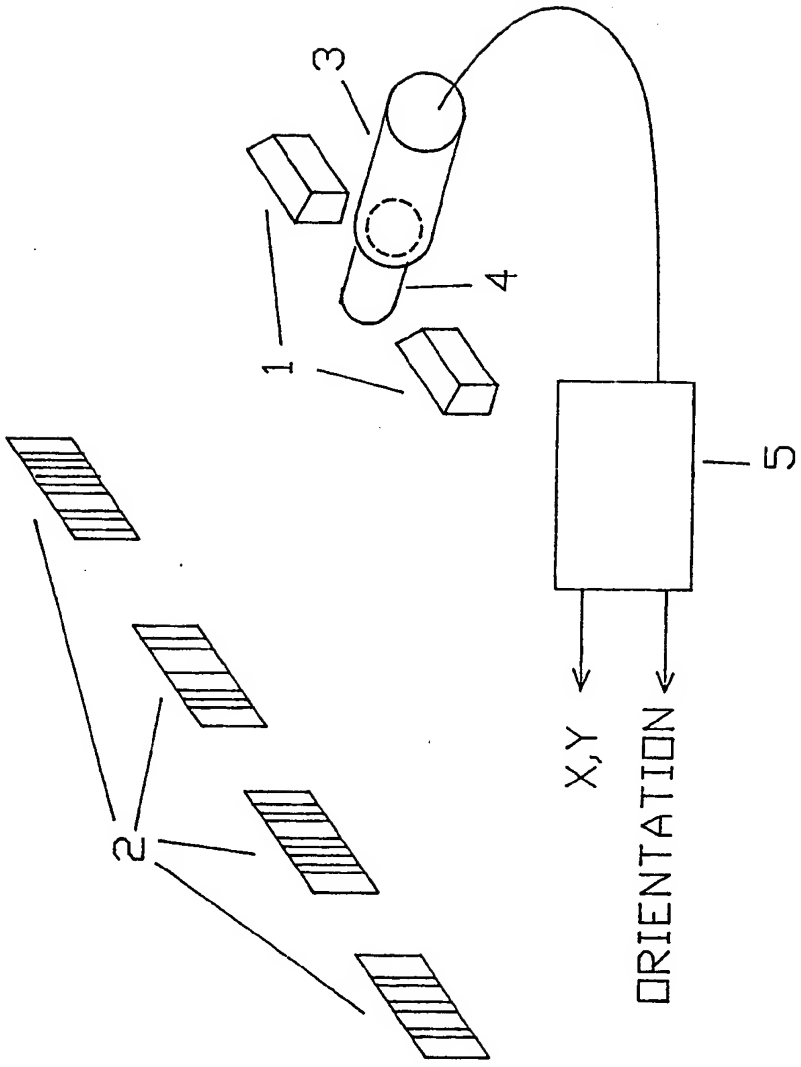


FIG -1-

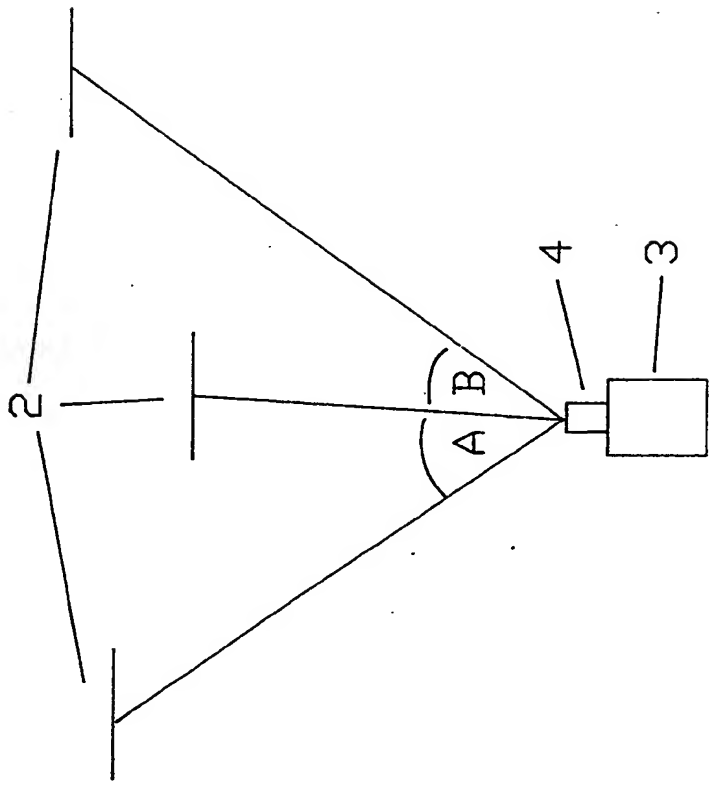
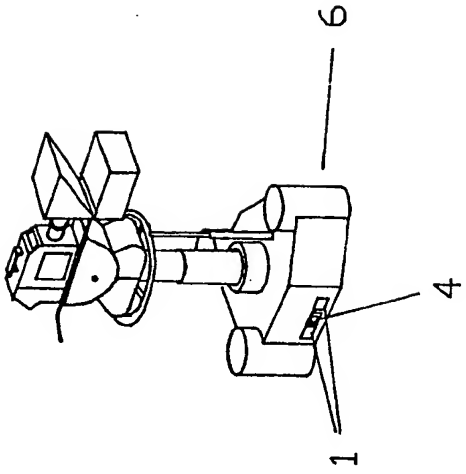


FIG -2-



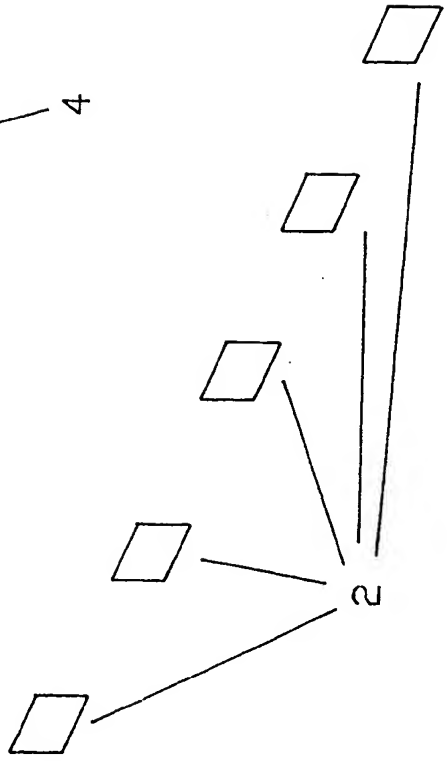


FIG -3-

NAVIGATION SYSTEM

This invention relates to a navigation system able to determine the position and orientation of a remotely controlled vehicle.

Remotely controlled robotic vehicles require a means to navigate their movements on a surface. To do this effectively, a navigation system is required, to allow the vehicle's control system to determine its X and Y co-ordinates and in some cases the orientation of the vehicle. In applications, where the vehicle is carrying other directionally sensitive equipment, the orientation angle produced by the navigation system is used to determine a reference for the on board equipment.

According to the present invention there is provided an optical scanning sensor in the form of a television camera, variable intensity illuminators to illuminate fixed reference targets positioned around the perimeter of the vehicle's area of movement and a computer system to process image information from the camera sensor.

A specific embodiment of the invention is now described by way of example with reference to the accompanying of drawings in which.

Figure 1 shows a general arrangement of the navigation system.

Figure 2 shows the geometric relationship between targets and sensor.

Figure 3 shows an application of the system for robotically controlled cameras in television studios.

Referring to Figure 1 which shows a general arrangement of the system, the principle of operation is as follows.

An illumination system 1 is used to illuminate an array of fixed reference targets 2 which are designed in such a way as to be individually recognisable by the navigation system using a pattern of reflective elements arranged to form a code. The positions of each of the targets with respect to an origin is known precisely and stored within the computer system. The illumination is arranged to ensure that all targets within the field of view of sensor 3 are adequately illuminated. It is also arranged so that as the vehicle approaches the targets, the power to the illuminators is reduced so that the brightness of the targets appear constant to the sensor. This is used to conserve power and to obtain consistent results from the sensor.

The computer system is pre-programmed with the X and Y positions together with the code identity of each of the targets. The positions of obstacles, boundaries, "no-go areas" and other reference points are also stored. A set of stored targets and other positions is referred to as a map. Different arrangements of targets and reference points used for different applications are stored on other maps within the computer. The map for the particular application is referred to by the computer when the navigation calculations are performed.

The sensor is fitted with a lens whose focal length and optical characteristics are known and stored within the computer system so that the position of the images of the targets formed on the sensor image plane can be used to precisely determine the angles subtended from the targets to the sensor, see Figure 2.

The angles subtended by the targets (represented by A and B in Figure 2) at the sensor and with respect to the sensor are measured by the sensor and by the use of trigonometrical relationships, in conjunction with the target positions as identified by the sensor system, the X and Y co-ordinates and orientation angle can be calculated.

To illustrate the navigation system's use more fully a specific application is described where it is used to navigate a robotically controlled television camera about a studio floor.

Figure 3 shows an arrangement of a robotic controlled pedestal used to position a broadcast television camera remotely in a television studio.

The targets 2 are positioned around the perimeter of the studio floor and specifically in positions easily viewable by the navigation sensor 4 mounted on the pedestal 6. In this example a linear array or line scan camera is used as the sensor. It is common practice to arrange the steering mechanism of the pedestal base so that it "crabs" whilst it moves around the floor. The crabbing movement ensures that the pedestal always points in the same direction whilst moving. The pedestal usually carries a remotely controlled pan and tilt head onto which the broadcast camera is mounted so that it can be pointed onto the subject being televised. Because this head is also under remote control, it requires a reference position so that camera shots can be repeated accurately. This reference is with respect to the pedestal base, and will be fixed provided the pedestal does not rotate as provided by the crabbing motion. Due to floor imperfections and other causes, slight rotation is usually experienced. The navigation system can detect this rotation and compensation is applied to the pan and tilt head so that the true reference is restored.

The inclusion of obstacle positional data within the computer system is used for example to prevent the robotic pedestal from running into the obstacles.

The inclusion of boundary and "no-go" positions is used for example to prevent the robotic pedestal from leaving a specified area of operation, or from entering a restricted area.

The inclusion of specific reference positions are used for example to :-

1. Control the pan position of the on-board pan and tilt head so that the subject, used as a reference, is kept in view whilst the pedestal moves about the floor.

2. Control the tilt position of the on-board pan and tilt head so that the subject, used as a reference, is kept in view whilst the television camera is raised or lowered by an on-board height control system.

3. Control the focus setting of the television camera automatically as the pedestal distance from the subject changes.

4. Control the movement of the pedestal from one location to other locations. All locations used as multiple references. The references can be selected in any desired order.

Obstacle positional data, boundary data and reference positions as described above are either permanently stored within the computer system, manually entered from time to time by an operator or generated and entered from an external control system.

CLAIMS

1. A remotely controlled vehicle navigation system comprising an optical scanning sensor in the form of a television camera, a means of variable intensity illumination to illuminate fixed reference targets positioned around the vehicles area of movement and a computer system to process image information from the camera.

2. A navigation system as claimed in Claim 1 wherein a television camera in the form of a multi element sensor line scan camera is used to view fixed reference targets.

3. A navigation system as claimed in Claim 1 or Claim 2 wherein an illumination system is used whose brightness is controlled by a computer system.

4. A navigation system as claimed in any preceding claim wherein X and Y co-ordinates giving position on a surface are produced.

5. A navigation system as claimed in any preceding claim wherein orientation angle of the sensor with respect to a reference is produced.

6. A navigation system as claimed in Claim 1 or Claim 2 or Claim 3 wherein the target positions necessary to perform the navigation calculations are stored in a memory system and that several sets of target positions are stored in separate arrangements so that the navigation system can navigate in several environments.

7. A navigation system as claimed in any preceding claim wherein obstacle positional data is stored in a memory system and that several sets of obstacle positional data is stored so that the navigation system can navigate in several environments.

8. A navigation system as claimed in any preceding claim wherein boundary positional data is stored in a memory system and that several sets of boundary positional data is stored so that the navigation system can navigate in several environments

9. A navigation system as claimed in any preceding claim wherein reference positional data is stored in a memory system and that several sets of reference positional data is stored.

10. A navigation system as claimed in any preceding claim wherein the data concerning obstacles boundaries and reference points is permanently stored in a memory system, manually entered by an operator or entered from an external control system.

11. A navigation system as described wherein with reference to Figures 1, 2 and 3 accompanying this description.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
9119860.6

Relevant Technical fields

(i) UK Cl (Edition K) H4D (DLAB,DLFB,DLPC,DLPG,DLPA)
G3N (NGA3,NGBX,NG5,NG1A4)

(ii) Int Cl (Edition 5) G05D

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner
DR E P PLUMMER

Date of Search
21 JANUARY 1992

Documents considered relevant following a search in respect of claims ALL

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	WHOLE DOCUMENT RELEVANT IN EVERY CASE	1 at least
Y	GB 2224613 A EL-UP ELECTRO-OPTICAL INDUSTRIES - nb page 5 lines 10-12 and figure 1	
Y	EP 0296405 A ARNEX HANDELSBOLAG	1 at least
Y	EP 0273976 A KK KOMATSU SEISAKUSHO and EP 0405623, US 4924153, US 4862047	1 at least
Y	EP 0236614 A SI HANDLING SYSTEMS and US 4817000	1 at least
Y	WO 87/02484 A CATERPILLAR and US 4678329, US 4684247	1 at least
Y	US 4967064 FIELD et al	1 at least

Category	Identity of document and relevant passages	Relevant to claim(s.

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